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 SUMMER 1975





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Front Cover:
Photo by Robert O. Joslin;
A Little Wood-satyr in sleep
position. This small butter-
fly is found in shady wood-
lands. The greenish white
larva feeds on grasses.

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*When we see ourselves as part of the environment,
we then can begin to treat it with love and respect.*

How we look at the environment inevitably determines how we treat it. In our modern computer age, we are able to compile facts on the environment at a fantastic rate. Yet facts, in and of themselves, do not solve environmental problems. Environmental problems are really people problems! The missing factor in the formula for a quality environment is CARING. Caring involves feelings, and feelings involve ecological consciousness.

Learning to care develops largely through direct personal experiences in our lives. For example, have you ever tried to "buddy" a butterfly? The children in the summer program at the Thames Science Center will have this experience. If you would like to try this activity, dissolve some sugar in your mouth. When you have located a butterfly, place some of the sugary liquid from your mouth onto your fingers. Move carefully. Extend your arm so that your fingers come into contact with the butterfly's taste organs on his front legs. If you are lucky, the butterfly will extend his drinking-straw mouthpart (proboscis) onto your fingers and begin to suck up the sweet liquid. What a rewarding experience for you or for a child—an opportunity to feel and see at close range a living butterfly! It is this kind of direct experience, when a person explores his feelings, that builds a lasting sensitivity to the natural world.

What does learning to care about the environment involve? It involves becoming more observant of the world around us. Look more closely at objects that you have taken for granted. You may discover things that you never saw before. An array of patterns, colors, and textures abound for those who see. Take time to look carefully. Use all your senses. Can you describe in your mind how things feel to the touch? Can you tell the difference in how things smell? When was the last time that you took a moment to listen to wind rustling through trees above or running water of a brook falling over rocks? Get in contact with nature! Discover relationships. We do not exist alone. We are part of a vast interrelated system. If we can see and feel the "whole" of the environment, instead of "bits and pieces," we have learned the need for caring.

Our caring for the environment must include other people, especially our children. It is these young people who will inherit the world we leave. It is our duty as parents and teachers to pass on a quality environment to our children and a sense of wise stewardship to maintain it. At the Thames Science Center, we are attempting to help children learn and care for the environment in many ways.

So when a child "buddies" a butterfly, he starts to care for it as a living thing. He begins to realize that, in nature's design for life, we all belong; and we all must learn to care.

There's A Bright Future In Store

Solar radiation not only warms the earth to life-sustaining temperatures, but also drives the hydrological cycle of evaporation and precipitation, powers the winds and the ocean currents, and is captured by photosynthesis to fuel the earth's biota. Wood, wind, falling water, and fossil fuels—man's historical energy sources—are all stored solar energy.

—(U.S. Senator Alan Cranston (California) in *National Parks and Conservation Magazine*, October 1974).

by Susan C. Rumney

During the energy crisis in the winter of 1973, Connecticut's vulnerability in terms of fuel supply came sharply into focus. We became acutely aware that our state has no significant indigenous sources of energy and that we are highly dependent on oil, particularly imported oil. In fact, petroleum products provide for the energy needs of over 80% of Connecticut's industrial, transportation, commercial and residential activities. It's no wonder, then, that many environmentalists, energy experts, legislators, and business and government leaders agree that alternate sources of energy must be fully explored and developed as quickly as possible, in order to reduce our dependence on resources over which we hold no control. The use of solar energy as such an alternative is emerging as a bright hope for providing a supplemental portion of Connecticut's energy.

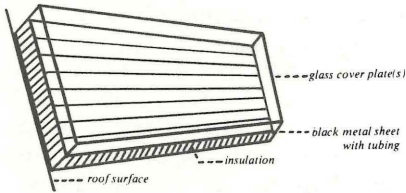
There are many applications of solar energy, each involving a different technology—heating and cooling of buildings, bioconversion, photovoltaic wind energy, and ocean thermal conversion. This article will focus on the use of solar energy for heating buildings, primarily because this technology has progressed the furthest of all the applications and because 65% of the energy consumed in Connecticut's residential sector goes to space heating.

Space heating with solar energy uses the sun's energy directly. Fossil fuel heating systems, on the other hand, rely on solar-energized photosynthesis, fossilization, extraction, delivery, and combustion processes that require hundreds of thousands of years to cycle.

Equipment

The essential components of a solar heating system serve the functions of collection, heat transfer,

storage, and distribution. Collecting solar radiation for heating a building is accomplished through the "green-house effect," the principle that visible light rays, after passing through glass, are transformed from light into heat energy. This infrared heat energy will not pass back through the glass and hence is trapped in the controlled air space. Here's a simplified diagram of a solar collector:



The collected heat is then transferred through a medium such as water or air directly to the heat distribution system (if it is a cold sunny day) or to a storage area. Since solar heat can only be collected during the daytime hours, storage is necessary in the form of either a large tank of water or a bin of dry crushed rock if air is the medium. When the house calls for the stored heat at night or during a period of cloudy weather, it is transferred to the living space for heating or to the domestic hot water supply as needed.

Nonetheless, a conventional gas- or oil-fired furnace or electrical heating element is needed as a secondary system. Sufficient solar radiation isn't always available in Connecticut due to prolonged periods of cloudy weather. Although it is possible to heat a house 100% with solar energy, the cost of providing ample storage space would be prohibitive.

Much of the hardware for the system is readily-available commercial equipment generally used for non-solar applications, such as

motors, pumps and blowers, heat exchangers, controls, pipes and fittings.

The most exotic and expensive piece of equipment in the system is the collector. At least 39 firms across the country are actively engaged in the production of solar collector panels, according to a recent Federal Energy Administration count. The Connecticut Energy Agency has material on file (available to the public) from many of these manufacturers. A list of Connecticut architects and engineers with solar expertise is also available.

Costs

There are certain requirements a house should meet before a solar heating system is installed. These include ample roof area (or ground space), orientation of the house toward the sun (south-southwest), and tilt of the collectors (15° plus latitude). Here in Connecticut, where we're at about 42° latitude, optimum tilt for the collectors would be $42^\circ + 15^\circ$ or 57° . They could, of course, be installed on a flat roof at that angle.

Bill Grover, Manager of Charles W. Moore and Associates, Architects and Planners, says "In terms of fuel savings alone, you can design a house with half the normal heating cost, simply with good insulation, proper orientation to the sun, provision for natural ventilation, thermal curtains or shutters, and a southerly overhang that will keep the high summer sun out." Mr. Grover goes on to say that you could cut the remainder of your heating bill in half again by installing a solar energy heating system. Thus, your solar heated house would consume only 25% of the fuel it normally would use during the heating season.

Generally, the ratio of square feet of collector to square feet of floor

space is 1 to 2, says Mr. Grover. However, if the house were designed efficiently, the ratio could be as low as 1 to 3. He stresses the need for an experienced architect to design the house, since half of the fuel savings are achieved through the architecture alone.

If you were to build a house with 1,500 square feet of floor space, Bill Grover estimates the solar heating system will cost \$5,000 to \$6,000 in addition to a conventional back-up system. If your annual fuel bill was estimated to be \$600 with a conventional system, you could cut your bill to \$150-\$200 by installing solar equipment to provide 60-70% of the total heating requirements, at the same time designing and insulating the house properly. If fuel prices continue their upward trend, the payback time of an estimated 12-15 years will, of course, come sooner.

Solar Activities in Connecticut

In speaking of the "costs" of solar energy, we should also recognize the societal benefits of a clean and abundant energy source made available through a process which causes no damage to the earth (except in the extraction and processing of materials used in the solar equipment).

Recognizing the benefits of solar energy in terms of long-range cost effectiveness and environmental desirability, Connecticut legislators proposed over a dozen bills dealing with solar energy during the 1975 legislative session. Of particular interest to Connecticut residents is committee bill #348, "An Act Concerning Tax Exemptions for Solar Energy Systems." The purpose of this bill is to exempt solar energy systems, windmills and waterwheels from the sales tax and to exempt solar energy systems from the property tax until the tax savings equal the capital cost of the system. Similar legislation has been enacted in

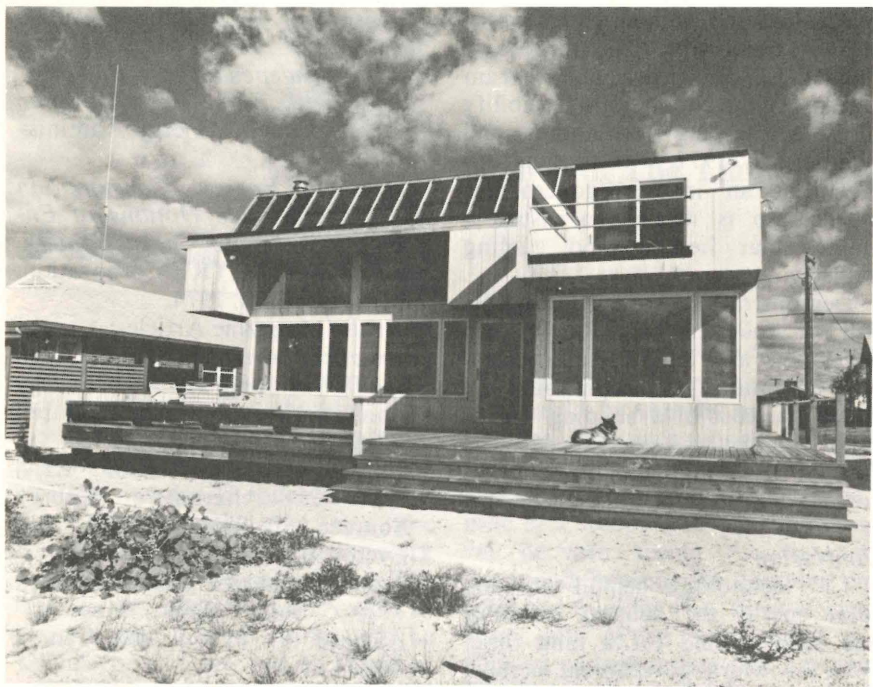
the states of Arizona and Indiana, and other states are considering it. (Editor's note: Bill #348 was favorably reported by the Regulated Activity Committee but has since been boxed by the Finance Committee. It will not have a chance of becoming a bill this year.)

The consumer has never had reason outside of environmental or moral concern to look for alternate energy sources. Since the embargo of October 1973, however, the rising price of fuel has made alternate sources more economically attractive than before. Crude oil, produced in OPEC countries, rose from nearly \$4 per barrel in 1972 to about \$12 per barrel in 1974. Electricity prices have risen dramatically and are expected to increase further. Incentive legislation is certainly one step toward encouraging the mass production critical to bringing down the costs of developing, marketing and installing solar panels.

Such legislation would coincide with other activities in accelerating the use of solar energy in Connecticut.

Already there are a number of building projects in Connecticut for which solar energy systems are being considered. School administrators in Groton, Old Lyme, Hartford and Waterbury have eyed the use of solar energy for new and existing school buildings. The Talcott Mountain Science Center is planning to build a new solar-heated laboratory, and a science center proposed for Wallingford may use it as well.

A 40-unit state-subsidized housing project to be located in Hamden will heat half the units with solar energy and the other half with a conventional heating system, for purposes of cost comparison. The National Science Foundation has provided a \$130,700 planning grant for the project, and the Department of Community Affairs is seeking a



This three-bedroom solar house in Westbrook, Conn. was designed to obtain 60% of its annual space and water heating requirements from a modular flat-plate solar collector system. Actual performance from August 1974 to April 1975 was above 66%.

federal grant for the \$300,000 to cover the additional cost of the solar-heated units.

The Connecticut National Guard is planning a new armory in Norwich and will utilize a solar heating system in the new facility. In addition, a solar-heated hotel has been proposed for New London, and a new solar-heated office building is being contemplated by a West Hartford businessman.

There are at least four solar-heated houses in Connecticut. Two are in Guilford, one in Stamford, and another in Westbrook.

Federal Activities

A recent Federal Energy Administration report summarizes 171 solar projects sponsored by 14 federal agencies between July 1973 and January 1975. Over half of these

projects were on the demonstration of heating and cooling buildings. The National Science Foundation was responsible for 130 of the 171 projects, funding \$19.3 million of the \$25.2 million total.

With the formation of the Energy Research and Development Administration (ERDA) in January 1975, the major responsibility for solar energy research shifted; and ERDA now stands as the lead agency in all federal solar research and development activities. NSF will continue to fund high-risk, longer-range solar projects.

A comprehensive solar research and development plan will be presented by ERDA to Congress on June 30, 1975. The plan will include the revision of the Solar Heating and Cooling Demonstration Act of 1974 and will provide for up to 2,400

residential and commercial demonstration units. The basic purpose of the federal demonstration program is to prove the commercial feasibility of solar heating for homes and buildings by 1977, with the philosophy that an industry/government partnership is needed to insure a viable solar heating and cooling industry.

Demonstration project proposals will be solicited by ERDA from developers and builders, and grants will be limited to the amount by which the cost of a building with a solar energy system exceeds the cost of a similar building with a conventional system.

Conclusion

The technology behind utilizing solar energy for heating buildings has been around for a long time. With the federal government increasing its demonstration and research activities and the state developing incentives for home owners to purchase and install solar heating equipment, there is indeed a bright future for widespread utilization of solar energy.

The Connecticut Energy Agency, 20 Grand Street, Hartford, provides information concerning applications of solar energy on request.

For further information the following are recommended:

Books/Reports:

The Coming Age of Solar Energy
D.S. Halacy. Avon, 1973.

Direct Use of the Sun's Energy.

Farrington Daniels. Ballantine, 1974.

National Plan for Solar Heating and Cooling—Residential and Commercial Applications—Interim Report. Energy Research and Development Administration,

Division of Solar Energy. Washington, D.C. 1975.

Project Independence Blueprint Final Task Force Report—Solar Energy. Federal Energy Administration. 1974.

Residential Energy Consumption and Small-Scale Options of Energy Systems for Space Heating. D.C. Chan. MITRE Corporation, Bedford, Mass. 1974.

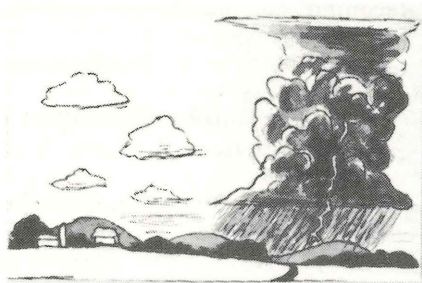
Journals/Magazine Articles:

Connecticut Architect March-April and May-June 1974. "Energy Conservation in Architecture" Part 1: Adapting Design to Climate. Donald Watson, AIA. Part 2: Alternative Energy Sources. Donald Watson and Everett Barber, Jr.

Natural Resources Journal. April 1970. "Solar House Heating." Richard A. Tybout and George O.G. Lof.

Popular Science. March 1975. "Now You Can Buy Solar Heating Equipment for Your Home." Richard Stepler.

Ms. Rumney is presently an Energy Analyst with the Connecticut Energy Agency. Before that she worked as an environmental analyst for 2 years with the Department of Environmental Protection. She devotes her spare time to gardening and piano ragtime and is a member of the Hartford Ragtime Entertainers.



Fear Not The Thunderbird

by Andrew H. Sims

A sudden summer storm, with its torrential rain, thunder, and lightning, is the most spectacular and the least understood of summer's weather moods. Thunder and lightning have fascinated man since time began. To the Greeks it was the work of Zeus; to the Teutons, Thor. The legends of the North American Indians are full of stories of the Thunderbird. Even today, thunderstorms have an aura of power and majesty unique among weather patterns; and well they should, for the energy involved in a typical thunderstorm is on the order of 10,000,000 kilowatt hours—roughly the same as a 20-kiloton atomic bomb.

Thunderstorms in the New England area are usually of the air mass type and are characterized by the cumulonimbus or "thunderhead" cloud. These clouds are the result of massive vertical movements of the air and extend upward thousands of feet. Thunderstorms are commonly bred on hot sultry days when the wind is light. On such days, there is a relatively extensive build-up of cumulus or "mashed potato" clouds in the late morning hours. These darken during the early afternoon as the increasing vertical development blocks out the sun. On days such as these, the sky to the west should be carefully watched because thunderstorms in our area generally move in an easterly direction.

Frequently, the arrival of a storm is foretold by the distant sound of thunder and occasional flash of lightning on the western horizon. The sound of thunder travels about a mile in 5 seconds, so the time interval between seeing the lightning flash and hearing the thunder can help you to judge how far it is away from you. When you couple this with an understanding that a typical thunderstorm moves at about 30 to 40 miles mph, you can even gauge how much time you have to seek cover before the storm is upon you.

Thunder is a byproduct of lightning and is caused by the rapid heating and expansion of the air along the lightning channel. Lightning occurs about 80% between the clouds and only about 20% between clouds and objects on the ground, but it is this 20% that does the damage.

High-speed photography has shown that a lightning strike is always at least a two-stage process and frequently more. The first stage is a series of steps, like jumps, from the positively-charged cloud towards the negatively-charged ground (or other cloud). When the channel has come within a distance of about 50 yards from the negatively-charged object, a return shot will start back up the freshly-opened channel. It is the return shot that provides the actual flash we see and the clap of thunder we hear. Sometimes this process is repeated several times until all the

stored energy has been dissipated. The typical lightning flash takes only a few thousandths of a second from start to finish.

Contrary to popular belief, a direct lightning strike does not guarantee death. Many victims have recovered with only partial loss of sight or hearing after severe lightning strikes, and many more have shown no permanent ill effects at all. A lightning victim suffers the same symptoms as any other victim of severe electrical shock and should be treated in the same way—prolonged cardiopulmonary respiration.

The best treatment of all is prevention, and here are a few simple rules:

—The worse places to be during lightning activity are in or near a small isolated shed (particularly one of metal), on a hilltop, near a wire or metal fence, or under an isolated tree.

—The best places to be are in a depression in the ground, in a deep valley, at the foot of a steep cliff, or deep in a grove of trees.

—Certain activities are inherently more dangerous than others. Never go swimming during a thunderstorm. Avoid using the telephone (several people are killed each year from lightning-struck telephone lines). Unplug the T.V. Stay inside your car if out in the open. Golfers are particularly vulnerable to lightning strikes because the metal spikes of their shoes makes a good ground contact.

Thunder and lightning should be recognized for what they are—a powerful force of nature—but they need not be feared. In the next few decades, perhaps, some of our increasing understanding of earth as a heat engine will allow us to use a thunderstorm's tremendous energy while reducing its unruliness.

Recommended readings:

The Lightning Book—Peter E. Viemeister, MIT Press, Cambridge, Mass.

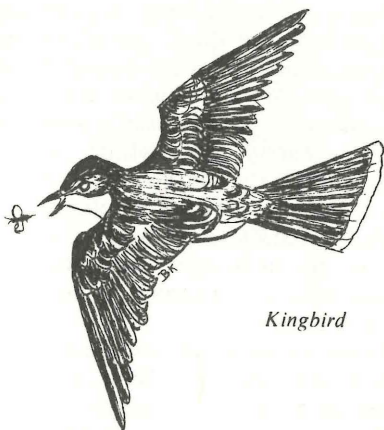
The Thunderstorm, Louis Battan, North American Library, New York, 1964

The Flight of the Thunderbolts, Basil Schonland, Oxford University Press, New York. 2nd edition 1964

Andrew Sims, who graduated from the U.S. Coast Guard Academy in 1959 with honors, now works as a consulting engineer for Vanderweil Engineering in Boston. A commissioned officer in the Coast Guard for nine years, Sims made two trips to the Arctic as a meteorologist on board the Northwind. The Sims family summers in New London.

Mr. Sims will be giving 2 courses on weather at the Science Center this summer. The dates and time will be listed in the July and August activity sheets.

Tyrants Of The Sky



Kingbird

*text and illustrations
by Barbara R. Kashanski*

Agile and quick on wing, tyrants of the sky—an apt description of an exclusively American family of birds, the Tyrannidae or tyrant flycatchers. Summer is a good time to observe this interesting family of birds. While many birds are elusive and hard to see among the leaves in woodlands and thickets, most of the flycatchers can be easily spotted flying over open fields or clearings in search of food, or noisily chasing some trespasser from their territory.

The flycatcher's method of feeding is to sit perched on a dead branch, post or fence watching for some unwary insect to pass by. They dart out, snap up the prey and return to the same outlook. This habit of returning to the same spot gives an observer more than one chance to get a good look at the bird.

Eastern Kingbird

Several species of flycatchers are summer residents in southeastern Connecticut. The eastern kingbird is quite common and can be seen along our roadsides or in open and semi-open areas. The fields of Bluff Point, Barn Island, and Haley Farm are good kingbird territory. I'm sure the king bird is responsible for the family name of tyrant flycatchers. This 8½ inch bundle of feathers is highly excitable and

aggressive. It is not uncommon to see a kingbird attack a hawk, owl, or crow that has ventured to fly over forbidden territory. The fury of these attacks is something to see. Often the kingbird will actually land on the back of the offending intruder and peck at it until the trespasser is chased clear of the invisible boundaries. In all fairness to the kingbird, though, it seldom bothers smaller birds. The kingbird is easily identified by the broad white band on the end of its tail. No other songbird has this field mark. Also, the kingbird is darker than most flycatchers on its head, back and tail, which contrast sharply with white underparts. Often the shrill twittering call, uttered in flight, will be the first indication this bold aggressive bird is around. Take a moment to watch him.

Great Crested Flycatcher

Another large, fearless and noisy flycatcher that can be seen here is the great crested flycatcher. It is the only member of the Myiarchus flycatchers found east of the Rockies. This group of flycatchers is characterized by their large size, olive head and back, yellowish belly and bright orange tail. All have wingbars. The crested flycatcher was once a forest dweller, but as the trees fell to the

woodman's axe in the early days of New England, this bird moved to more open areas. Today it is found in deserted orchards and thicket areas near woodlands. The crested's loud unmusical alarm note, wheep, is repeated frequently and helps locate this bird. Once its favorite perch has been discovered, you probably can find it in the same spot, the same hour, day after day. It seems to be a creature of habit.

The nest of this handsome bird is an interesting structure. Built anywhere from 5 to 60 feet above the ground in a hollow trunk, fence post, or deserted woodpecker's hole, the nest is a fairly compact structure full of goodies. The building material includes trash, moss, twigs, hair, leaves, grass, fur, feathers and anything else the bird can lay its beak on. The *pièce de résistance* is usually one or more snake skins! Just why the crested uses cast-off snake skins is still unknown. One popular belief is the birds use the skins to scare off would-be nest robbers. This would be a plausible

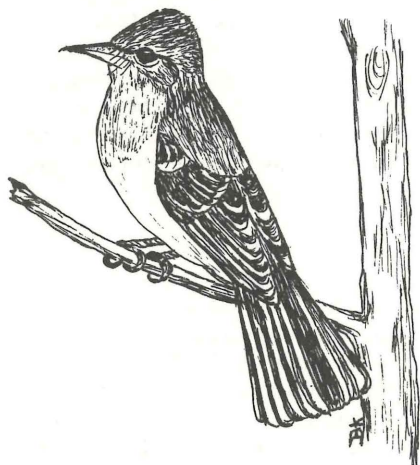
theory except for the fact that sometimes the skins are so hidden in the mass of other material a predator wouldn't even be aware that they were there. It certainly does make this flycatcher's nest a little different.



Phoebe

Whether you are a bird watcher or not, I'm sure the next flycatcher will be familiar to you—the phoebe. Certainly this medium sized friendly flycatcher doesn't conjure up any visions of a tyrant. Phoebes are the first flycatchers to arrive in the spring, usually by the end of March in this part of Connecticut. They seek areas near water when they first return. Food is an important consideration at this time of year and the earliest emerging insects develop in swamps, ponds and streams. As the insect season gets into full swing, the phoebe will stake out its territory and start building a nest of mud, lined with fine grasses, roots, feathers or dry moss. Preferred sites are under overhanging banks, under bridges or eaves, and inside farm buildings. Once a good nesting site has been found, the phoebe will use it year after year. Often a new nest will be built right on top of the old one and this will continue until the bird runs out of head room.

The phoebe is a plain-looking bird without any very distinguishing field



Crested Flycatcher

marks like wing-bars or eye-rings. Its habit of jerking its tail downward while sitting on a perch helps identify this flycatcher as does its call of fe-be. What it lacks in looks, it makes up for in personality. No doubt you have a phoebe living close at hand, but if you do not, there is a pair nesting under the overhanging banks of the former gravel pit at Barn Island. Haley Farm, with its many old farm buildings and pond areas, is sure to have a phoebe or two.

Wood Pewee

Similar to the phoebe in looks and gentleness is a member of the olive-sided flycatchers—the wood pewee. The pewee prefers to live in a woodland habitat, as its name implies, and while perched on a dead limb or bare branch does *not* wag its tail like the phoebe. One good identifying field mark is the prominent wing-bars. A dead give away is its song, a sad and plaintive pee-oo-wee. Wood pewees build their shallow, saucer-shaped nests on a nearly horizontal branch. The outside is covered with bits of tree lichens, and, from below, the nest looks like a knot or growth on the limb. The Connecticut Arboretum, Devil's Hopyard, or Nehantic State Forest are good places to go prospecting for the wood pewee.



Wood Pewee



Least Flycatcher

Smallest of the New England flycatchers is the least flycatcher (5-5¼"). Found in open woods, at the edge of woodlands, or in cultivated areas, the least flycatcher can be identified by its call, a sharp se-bec, or by its wing-bars *and* eye-rings. The other flycatcher that might be confused with the least, if they are found in the same area, is the alder (formerly Traill's) flycatcher. Habitat and call note are the best ways to distinguish between the two, but now we are getting into an area for the experts.

The flycatcher family can be confusing for the casual birdwatcher. The five most common species that I've mentioned would be good species to start with. If you are beyond the beginning stage and need to build up your life list, you could go looking for the pair of Acadian flycatchers that have been nesting in the Devil's Hopyard for the past several years. Also of interest for the advanced birder is the pair of willow flycatchers that have nested in the Harkness State Park area for the past three summers. (In 1973, the Traill's flycatcher was subdivided into two separate species—the alder and the willow.)

If you come across any interesting or unusual sightings while you are out prospecting for Tyrannidae, please call the Science Center and let us know what you have found.

A Spartan Life

by Eric Leinbach

Plants and animals show an amazing ability to adapt to life under the most adverse conditions. Nowhere is this more clear than by the shore, where conditions are especially inhospitable. Beach, dune, rocky edge, or saltwater marsh—they all pose severe survival problems. The challenges are many and varied. Shore life must adapt to extreme winds, baking sun, sudden temperature changes, lack of cover, insufficient fresh water, periodic flooding, poor soil and many other problems. But most important, all life along a coastal shore (such as here in eastern Connecticut) must adapt to the constant presence of salt. This is especially true of the plant community, which, in order to survive this salty environment, has had to show the greatest degree of adaptation and change.

To understand a plant's need for special adaptations to cope with salinity, one must first understand that to most plants, salt is a deadly enemy. All of life's processes take place in water solutions of some type. This is true of the cells of living plants, which must be wet to function properly. Living cells not only need to be wet; they also require a careful balance of dissolved and

suspended materials within their fluids. If the concentration of water, relative to dissolved materials, is not controlled, the system breaks down and the cells die. Salts are one type of dissolved material the plant must regulate.

Several Plants Adapt

Several species of plants have adapted to living along the edge of the shore where they receive salt spray yet do not have to deal with high salt concentration in the soil. The main problem for these plants is drying out from the salt air and sea winds. Their adaptations often involve thick, waxy, small, hairy, or folding leaves—all to prevent moisture loss. The following are just a few of the plants you could find on the upland edge of the shore: scrub oak, black cherry, pitch pine; beach plum, bayberry, salt-spray rose; seaside goldenrod, dusty miller, seabeach sandwort; grape, Virginia creeper, poison ivy. Through various mechanisms, these plants can tolerate salt air but not salt water at their roots.

Closer to the sea, in areas where dryness, lack of nutrients, and salt concentrations eliminate most other plants, the familiar beach grass

(*Ammophila*) is able to grow. This hardy plant thrives in exposed areas of pure sand where often there is no shelter from the sun, wind, or salt. Its ability to survive such unfavorable conditions is due to the plant's adaptations for utilizing the moisture found in sea air. The roots and creeping stems of beach grass grow quickly and in great quantity, yet they absorb almost nothing of value to the plant. Even in times of hard rain, they serve primarily to anchor the plant and to help it to spread. So where does the plant get needed water? It takes it directly from the moisture-laden air through specialized leaves. During rain, fog, and humid times, the leaves of this plant open flat and use the deep lengthwise grooves on their lower surface to exchange gases and absorb water vapor from the air. When fog burns

off and the sun beats down, the problem changes to one of water conservation. Each leaf then curls until it is almost a hollow tube. The ridges, between the lengthwise grooves, come together to seal out the wind and to reabsorb the moisture that diffuses out of the plant. Beach grass survives in a dry and salty location simply because it has adapted to the extent that it can capture from the sea air the moisture and essential nutrients it needs.

Ultimate Examples

The ultimate examples of a plant completely adapted to the rigors of a saltwater environment are found in the salt marsh areas along our shores. Out of thousands of American plant species, only two can thrive in this salty situation; and they dominate the salt marshes of the East coast. The two species are Salt-meadow Grass (*Spartina patens*) and Smooth Cordgrass (*Spartina alterniflora*).

These grasses grow in vast carpets in salt marshes despite high concentrations of salt in the water, soil and air. *Spartina alterniflora* is a large coarse grass that grows in dense stands along the waterways enjoying tidal flooding. In contrast, *Spartina patens* is a fine, small grass that grows on the drier marsh flats in thick mats. *S. patens* is the salt hay that is so highly prized as a mulch and hay because of its very high nutrient content. While different in appearance and liking slightly different habitats, both these plants depend on similar adaptations.

These plants have solved the problems of salinity by increasing the concentration of salts in their cells so that it is above that of the surrounding salt water. Water then moves into the cells from the seawater just as it moves into other plants from fresh water. A high concentration of selective salts that have



Beach grass
Ammophila

little to do with the internal functioning of the cell continues, and thus the normal cell operation is not upset.

Table salt, sodium chloride, is the most common salt in seawater. It is this salt that is most highly concentrated in the two species of marsh grasses because sodium, itself, has little to do in plants. They do need it to grow but only in minute quantities. Having high internal concentrations of salt, and utilizing special selective membranes on their roots, these plants have solved the difficult problem of water balance. Other problems still remain, though, such as the buildup of salt concentrations in the sap.

Like all plants, these grasses lose water through evaporation. This is a controlled process that is regulated through special pores on the leaves called stomata. These special pores close at night or when the plant does not need to produce food, to conserve water. During the day, however, when food is being manufactured, these stomata open; and water is lost through evapora-



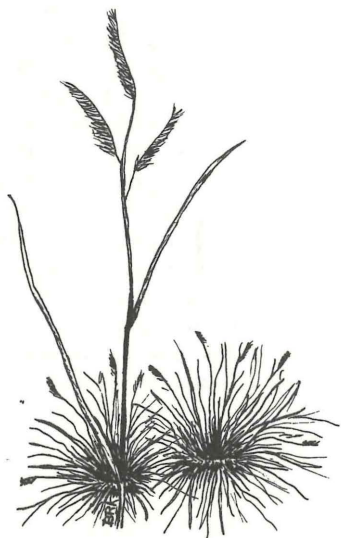
Smooth Cordgrass
Spartina alterniflora

tion. This evaporation is necessary for cooling and for maintaining important osmotic pressure within the plant. But as water evaporates from the plant, the small quantities of salt, that are always present in the sap, tend to concentrate. If left unchecked, this accumulation would eventually kill the plant.

Spartina has evolved special glands to eliminate this salt. These glands are scattered over the surface of the leaves, and they secrete salt in a very concentrated solution through special pores that lead to the outside of the leaf. Once outside, the water that is secreted with the salt evaporates, leaving little salt crystals that cling to the leaf until the next high tide. As a result, these plants often sparkle in the sun.

Getting Oxygen

In addition to the problems caused by a saltwater environment, marsh plants have other handicaps to overcome. A big one is the lack of oxygen. Like all living things, plants (and especially their roots) require oxygen and other gases for their life processes. Getting oxygen to the roots of the *Spartinas* presents a real problem.



Saltmeadow grass
Spartina patens

The muds of the salt marsh are almost devoid of oxygen. Twice daily the marsh is flooded by the tides, and the air spaces in the soil are filled with water during this flooding. Gases, such as oxygen, move extremely slowly through water. At the same time, the surface of the marsh soil is a very active area with bacteria and higher organisms living there in great numbers. As a result, oxygen consumption at the soil surface is very high, reducing available oxygen to the areas below the soil surface. *Spartina* has developed a complete system to overcome this handicap.

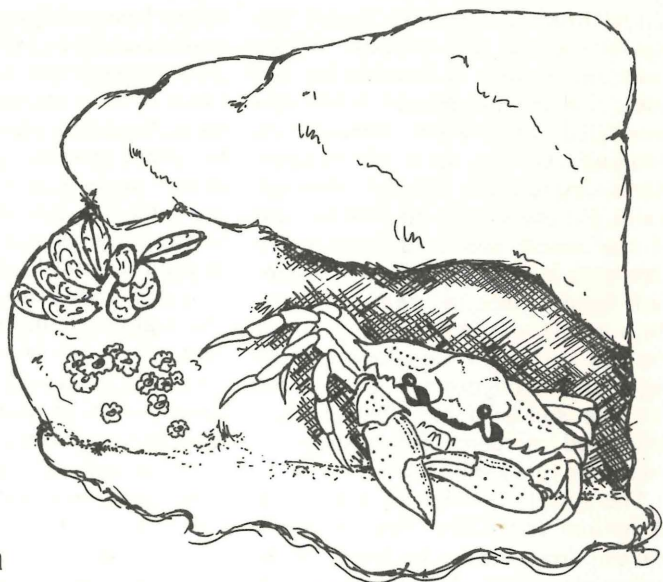
The system consists of a network of hollow tubes that run from the leaves down into hollow spaces within the roots. All the spaces are full of air and are open to the outside through the stomata on the leaves. This pipeline of air allows oxygen to travel through the plant and down into the roots. It is not necessary for the air in these ducts to move. Oxygen, through a process known as diffusion, travels from areas of high concentration to areas of lower oxygen concentration. As the roots use oxygen, the oxygen concentration is lowered and a new supply moves in from the higher outside concentration. An important consideration in this whole system is that diffusion is only 1/10,000th as fast in water as it is in air. This means that no part of the passages can be allowed to fill with water. At high tide the plants must quickly close their stomata.

Piping oxygen down to the roots does more than just sustain the root system. It benefits the plants in other

ways. Excess oxygen from the roots is released into the surrounding soil. This is important to the grasses because of their unusually high requirement for iron, an essential nutrient for plant growth. Iron exists in the marsh muds as iron sulfide which is insoluble in water and thus of no use to the plant in this form. But when oxygen is added, the iron sulfide is oxidized and forms, as one product, the highly soluble iron, ferrous sulfate, which can be used by the plant. Thus, by releasing oxygen through the roots, the grasses are able to meet their iron requirements.

These hollow air spaces in the roots also help expand the plant's root system without using additional plant material, an important adaptation for a plant that depends on a large root system to keep it from getting uprooted in the moving tides. It is another small adaptation that helps this plant live where others have no chance. By many small adaptations, the *Spartina* grasses have adapted to life in an environment that is far from ideal for growing things. This lack of competition has enabled them to dominate the salt marsh.

In one way or another, all the plants along our shore have adapted to a difficult life that is continually influenced by the forces of the sea, sands, winds, tides and ever-present salt. Yet this habitat, so inhospitable to most living things, supports a whole host of organisms. When you next visit the shore, look with respect. The shore is a beautiful and relaxing place for us, but it is a harsh world for those living things that struggle to exist there.



Little Green

by Laura E. Kezer

illustrated by Paula Smith

The clicking, silvery shadows scared Little Green so much that he jolted backwards, still further under the rock, only to shoot forward again because every rough point of the rock seemed like needles going through his soft shell. Eight-pointed legs danced, his two stalked eyes turned this way and all around that way, his antennae swept nervously through the water, but all that Little Green could now sense was a pudding-slap of quiet night water against his rock. Four legs on either side digging outward, he tried to settle into the rock-sheltered sand, but each piece of sand seemed to stick into his abdomen. Little Green hovered miserably under his rock. The water kept slap-tapping.

Little Green wasn't conscious of being hungry, but he returned to stuffing food into his mouthparts, having first shredded it with his two large front claws. Little Green was simply doing what came naturally to him. If somebody knowledgeable about the ways of crabs had looked

under that rock, he would have recognized Little Green as a common green crab, scientifically known as *Carcinus maenas*, who was eating his molt, or cast-off shell.

Had he a memory, Little Green would have known why he was frantically ripping at and eating the limp object in front of him. Just as the quiet of sunset water had come, Little Green had completed an awkward dance that had been going on for several hours. His backward, clumsy activities had been a bit like pulling out of boots and snowclothes when they are wet to your skin. Little Green must have felt just as soggy, for he was full of extra water. All this dancing about and eating and being full of water was part of the way in which he had managed to grow up a little bit.

Crabs begin their lives as hundreds of eggs that are carefully carried about on the abdomens of mother crab. When Little Green was first hatched, he didn't look anything like a crab. Indeed, you

could not have seen him even if you knew where to look unless you had a microscope. He was a transparent speck with feathery oars to move himself about on the surface of the ocean. But he kept changing, until finally he lost the feathery arms and settled on the bottom sand. Little Green was still very small when he became a bottom creature. He had a hard stiff shell which was sealed all over him, but he needed to do a lot more growing. No legs sticking below too-short pants for him; he had to squirm out of his armorlike shell completely and start a whole new set of clothes. Maybe it was because he was thirsty, but at any event, when Little Green had begun to feel cramped in his shell, he had gulped in water and more water and his body had begun to expand. And, somehow, the need for water was so great, that all the water in the tissues of his legs and claws also went into his body, leaving very little in that part of his shell. R-r-rip—Little Green had become so puffed up that his shell burst neatly along the back. And he knew to dance and twitch like itches until he pulled his waterless shriveled legs out of each of their leggings, to tuck his eyes down close to his inside body, and to back out of his old tight shell.

When he had finally gotten out of that cramped shell, Little Green looked just the same, but he certainly didn't feel it. Only a day before he'd been a cocky, "I'll fight you over any dead creature that will be my meal"—sort of crab. Little Green finished eating his old shell. The calcium would help his new one grow strong and hard in several days.

Usually the night water seemed friendliest, but tonight each movement unnerved Little Green. The clicking, silvery shadows kept darting by—tiny shrimp feeding on still tinier creatures. Little Green watched with envy as a colorful lady crab

swam past paddling with its rounded rear legs. Even when he was hard and strong, Little Green wasn't very good at swimming, for all of his legs ended in pointed tips. He was, however, a very good runner. It didn't seem at all unusual to him to go sideways, for the way in which his legs were jointed made it the most efficient direction to move.

Feeling so naked, Little Green almost envied the periwinkles slowly sliding over the rock. The little snails were always protected by a hard shell; they grew by simply adding more shell at the edges. But they were making an awful racket as they scraped food off the rock with their unique rasplike tongues. And the blue mussel next to him looked so secure. It had just finished feeding. Its two shells were firmly locked shut, and it was safely anchored to the rock by the golden thread it had spun earlier.

For several days Little Green remained poised and jittery under his rock. Then suddenly he felt hard, mean and hungry again. Fighting claws held menacingly in front, Little Green left the rock shelter and went hunting for a meal.

Suggested reading:

The Knight in Crusty Armor, Cox and Applebaum, Golden Press, N.Y., 1974

Crabs, Zin and Krantz, William Morrow and Company, N.Y., 1974

Crustaceans, Schmitt, University of Michigan Press, Ann Arbor, 1971

Pagoo, Holling and Holling, Houghton Mifflin Co., Boston, 1957

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The Devil's Hopyard State Park

by Shelley White

The Devil's Hopyard in East Haddam is one of our most popular state parks. One shouldn't infer from this, however, that Connecticut residents are overly fond of old Satan, or even that they partake more than any others of that brew to which hops add such sweet flavor. The devil, in fact, has not been reported in the area for a long, long time. For that matter, records of his earlier visits are not conclusive. Of the hops that may or may not have been grown there, little evidence remains.

The attraction, of course, is the wild beauty of this state park in the Eight Mile River valley. One of the few unspoiled ravines in southeastern Connecticut, its focal point is Chapman Falls. Here the Eight Mile River plunges over a 60-foot stepped escarpment into a deep gorge. Through the ages the falls have sculpted the rocky ledges into varied, interesting shapes. Most interesting are the depressions called "pot-holes," which are such perfect ovals they look as if they had been smoothed and rounded by hand.

These potholes vary in circumference and depth. Some are quite small, only inches deep. Others are large enough to "hide the dressed carcass of a hog," as one earlier writer expressed it with an accurate, if unappealing, figure of speech.

These potholes are formed when the current traps a stone in an eddy and spins it around and around. The stone eventually wears a depression in the softer Scotland schist of the underlying ledge rock. It takes hundreds of years to fashion a pothole.

There are reportedly few better examples of pothole development in the East. Even the casual visitor with no knowledge of geology is intrigued by these formations.

Upheaval, erosion, and glacial activity all helped to fashion the Eight Mile River valley. In the limited sunlight and cool north-south conditions typical of ravine areas, there is a beautiful grove of fine hemlocks, cool and quiet and still. Evidence of the ancient glacier that pushed into the area is provided by many jumbled rocks, including one particularly huge boulder. This "erratic," carried from an unknown region by the glacier, now rests a few hundred feet southwest of the falls. It looks like a gigantic, somewhat flattened, monolith.

There are various legends about the origin of the area's name and a plausible story that cannot be completely authenticated. Two meanings are given to the word "hop" by different versions of how the area was named. While most versions regard hop as the plant, others see it as a verb and have the devil or other evil spirits hopping about making potholes.

The hoariest legend on the origin of the name has a timid person passing along the road at night and imagining that he sees "many mist-shrouded forms of weird shapes leaping from the ledges and trees and dancing about the hopyard." He flees in terror and reports that the hopyard must be the devil's. Very similar stories have appeared repeatedly throughout folklore, not only of New England but every-



drawing by Dana Hammond

where, to "explain" how a place name originated.

A somewhat more interesting legend about the name concerns the wayward son of a minister who lived in the area. The son, an incorrigible practical joker, finally so irritated the community that he was forced to leave. He returned secretly several years later, according to the story, as addicted as ever to the practical joke. Combining his love of a joke with his wish to get even with those who had forced his departure, he dressed himself in a "grotesque costume," put on a mask with "formidable horns," and rode his horse swiftly along country roads "making hideous noises." Panicky people thought he was the devil, and since he always rode toward the hopyard, custom made it the devil's. The suspicion is that this practical joker was no more real than the evil spirits cited by the timid traveller.

A third legend concerning the origin of the name is somewhat more involved, but it also revolves around

the wayward son of a pious man. The man, Obadiah Brown, was said to have been an associate minister at the Millington Church. A son, Abraham, "was a mischievous schoolboy, frequently flogged by the school-master . . . with rawhide." To protect his hide, Abraham broke into the church and took the sheepskin cover of the pulpit Bible, which he converted into a body shield.

For this he was sent to jail and after release was disowned by his father and turned out of his house. Abraham found lodging with a kindly neighbor where he met a gentleman from Cuba who, hearing his story, offered to take Abraham to Havana. Abraham accepted the offer.

In this story the Cuban proved to be the practical joker, or perhaps his sense of justice required him to shock those who had ill-used a boy originally guilty of nothing more than high spirits. The man from Cuba acquired a bull's hide with horns still attached. He "wrapped it around him and with Abraham by

his side drove furiously by the house of Mr. Brown" at dusk. Abraham's brother and a friend saw this spectacle and excitedly reported seeing Abraham "driving down Kettle Hill Road in a wagon with a horned devil."

The story continues with Abraham's return a decade later. He built a house at the falls and installed a witch for a housekeeper. He subsequently returned to Cuba, leaving all his wealth to the beautiful daughter of the neighbor who had befriended him years earlier. The night he left, his house burned down, and later the vessel he sailed on was lost at sea with all aboard. These ingredients were stirred into a "romance" written by Judge Hiram Willey that was published in four issues of the *Connecticut Valley Advertiser* in 1909. Little of this story seemed based on fact.

The angry devil legend also appears among the Devil's Hopyard's stories. In this version, the devil was playing about the waterfalls when something annoyed him. Thus, wherever he jumped or hopped, he burned a hole in the rock.

The most plausible explanation of the origin of the name is that a man named Dibble lived in the area and raised hops. It was called Dibble's Hopyard, which through the years became corrupted into Devil's Hopyard. This explanation is attributed to one Alfred Chapman, who reportedly passed it to a George K. Babcock in 1860. There are no records of anyone named Dibble owning land in East Haddam, but Dibble families did live in Colchester and it is possible that someone of that name may have lived in a house at the hopyard.

Early settlers often applied the devil's name to wild, inaccessible, or isolated spots, especially if they were characterized by jumbles of

boulders and rocks. These earlier folk had an ability to see many examples of the devil's handiwork which we sophisticated moderns lack.

Scenery, as impressive as it is, does not alone attract people to the Devil's Hopyard today. The cool waters of Eight Mile River provide fine fishing for brook trout. The trout are stocked, but migratory fish, including American and lamprey eels, travel to the base of the falls each spring to add variety.

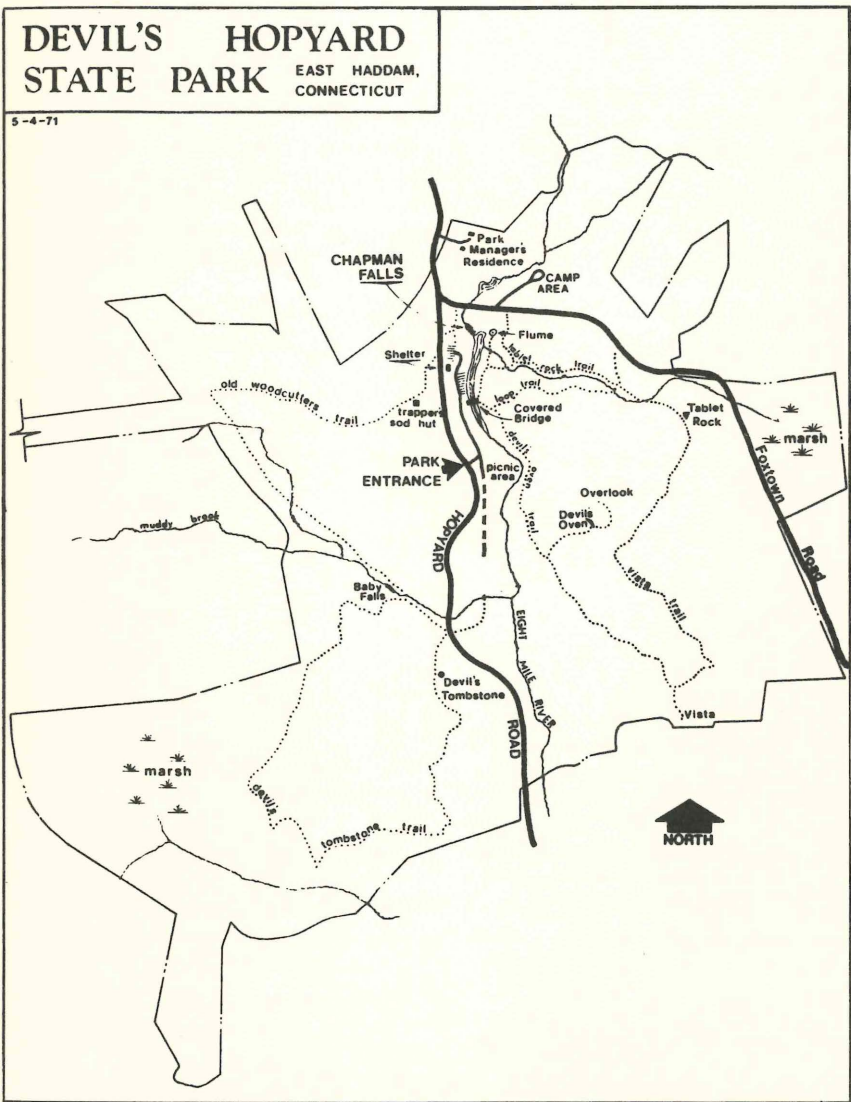
There are 15 miles of foot trails, logging roads, and connecting paths winding among lofty hemlocks, following the curving river, or rising over steep, rocky hills within the 860 acres of the park. You can visit the Devil's Tombstone or the Devil's Oven or climb to a scenic overlook. You can eat at a picnic table shaded by the hemlocks and listen to the restful sound of falling water. Or you can camp at one of the 27 wooded and open sites for tents and trailers.

The park is located five miles south of Colchester on Route 82. The park manager's residence is just above the parking lot at the top of Chapman Falls. He is the person to see for further information on camping or about the park in general.

When you visit this delightful park, imagine how mysterious and wild it appeared to those living in olden times when witchcraft and the personal appearance of the devil were commonly believed in. Those cauldrons or potholes could easily have been made by a supernatural force. You may not need to transport yourself back in time at all, however, to conjure up an image of the devil when you spot a beer can littering the area today. The Devil's Hopyard, indeed! Pick it up to help keep the devil in his place and the hopyard unspoiled.

(Author's note: Information for this article came from William F. Miller, chief of the Parks and Recreation Unit of the Department of Environmental Protection, and were originally compiled by Francis H. Parker (1920) and the *Manchester Herald* (July 30, 1928). Richard Krueger, geologist, supplied the

correct geological terms. A complete description of the geology of the area can be found in Quadrangle Report No. 19 of the State Geological and Natural History Survey, *The Bedrock Geology of the Hamburg Quadrangle* (1966), by Laurence Lundgren, Jr., available from the state librarian in Hartford.)





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